**PCT** WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :
**F23J 3/00, F28D 7/00, 13/00**
**F27B 15/12 // F23C 11/02**

**A1**

(11) International Publication Number: **WO 91/17391**

(43) International Publication Date: 14 November 1991 (14.11.91)

(21) International Application Number: PCT/SE91/00305

(22) International Filing Date: 29 April 1991 (29.04.91)

(30) Priority data:
9001563-7 30 April 1990 (30.04.90) SE

(71) Applicant *(for all designated States except US)*: ABB STAL AB [SE/SE]; S-612 82 Finspong (SE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)* : BRÄNNSTRÖM, Roine [SE/SE]; Pirvägen 38, S-612 00 Finspong (SE). MOLNAR, Antal [SE/SE]; Fogdevägen 4, S-612 00 Finspong (SE).

(74) Agent: LUNDBLAD VANNESJÖ, Katarina; ABB Corporate Research, Patent Department, S-721 78 Västerås (SE).

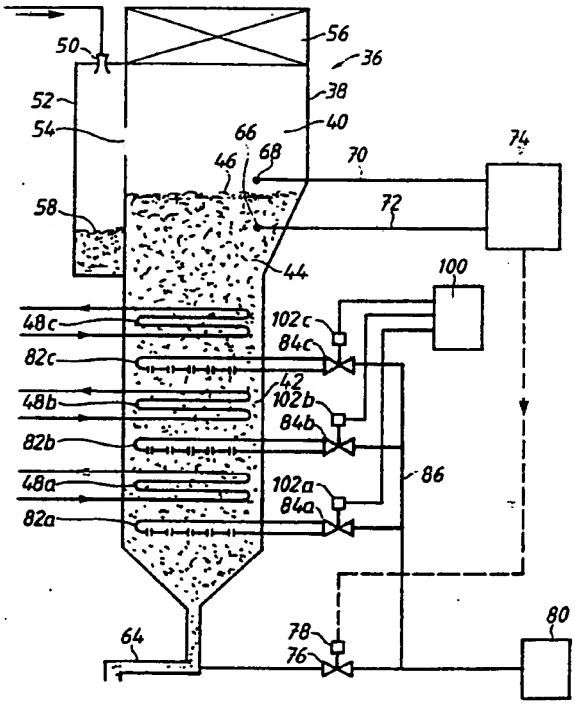
(81) Designated States: AT (European patent), AU, BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FI, FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.

Published
*With international search report.*

(54) Title: A COOLER FOR COOLING OF PARTICULATE MATERIAL, ESPECIALLY FINE-GRAINED DUST

(57) Abstract

A cooler for particulate material from a combustion plant, especially for cyclone ash form a PFBC power plant, in which the material is transported pneumatically with flue gases as transport means. At the inlet of the cooler there is a space (40) for separation of the particulate material from the transport gas. The transport gas is removed via a gas cleaner (56). The particulate material (44) is collected in a duct (42) where it forms a particle column. The duct includes cooling modules (48a-c), suitably water-cooled, which cool the material on its way down through the duct. The duct comprises devices for the supply of a gas which removes flue gases from the material in the duct.



# A cooler for cooling of particulate material, especially fine-grained dust

## TECHNICAL FIELD

The invention relates to a cooler for cooling of particulate material. It is particularly intended for cooling of very fine-grained dust, for example dust which has been separated from flue gases from a combustion plant with combustion of a fuel, primarily coal, in a pressurized fluidized bed before the gases are supplied to a gas turbine. A plant of this kind is generally called a PFBC power plant. PFBC are the initial letters of the English expression Pressurized Fluidized Bed Combustion.

## BACKGROUND ART

During combustion of coal in a fluidized bed of a particulate sulphur-absorbing material, for example lime or dolomite, a large quantity of ashes from the fuel and fine-grained absorbent residues accompany the flue gases. This dust is separated from the flue gases in a cleaning plant, usually consisting of cyclones, before the gases are utilized for operation of a gas turbine. In the following, the separated dust will be referred to as cyclone ash. The combustion is performed at a pressure considerably exceeding the atmospheric pressure. The pressure may be about 20 bar, is usually between 12 and 16 bar at full power, but is lower at partial power. The combustion of the fuel is performed in the bed at a temperature of the order of magnitude of 850°C. Combustion gases and accompanying dust have the same temperature as the bed. Also the separated dust, the cyclone ash, has this high temperature. Therefore, the handling entails considerable problems.

To be able to handle ashes, the following must be done:

mentioned kind designed as a cooler is described in European Patent No. 0 108 505.

In a second cooling stage, the cyclone ash may be cooled with water and the heat contents be utilized for preheating of, for example, feed water or distance heating water. The fine-grained state and poor thermal conductivity of the cyclone ash render the cooling difficult. To obtain good contact between ash and cooling surfaces, the cyclone ash is suitably fluidized in the cooler. Discharge of heat with the fluidization air entails an undesirable heat loss.

Swedish patent application 8802526-7 shows a cooler designed as a water-cooled transport screw. US Patent No. 4,492,184 shows a cooler designed as an inclined bed vessel where cyclone ash forms the bed.

SUMMARY OF THE INVENTION

According to the invention, a cooler for particulate material, especially a fine-grained material which has been separated from flue gases from a combustion plant and transported pneumatically to the cooler with flue gases as transport gas, comprises a space for separation of flue gases and dust, an outlet for the flue gases, a downwadly directed, suitably vertical duct with cooling devices, devices for the supply of gas, suitably air for the removal of flue gases from material flowing downwards in the duct, and a material discharge device at the lower part of the duct.

In a PFBC power plant the cooler in the first cooling stage is suitably located in the pressure vessel of the plant and the cooler in the second cooling stage outside thereof. The space for separation of transport gas and dust is located at the upper part of the cooler and above the above-mentioned duct. Transport gas and dust are suitably supplied to the cooler via a pressure-reducing nozzle and a reception

Figure 3 shows an air nozzle.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the figures, 10 designates a pressure vessel. A combustor 12, a cleaning plant 14 and a pressure-reducing discharge device 16 are placed in the pressure vessel 10. Fuel is supplied to the combustor 12 via the conduit 18 and is burnt in the bed 20. Steam generated in tubes 21 drives a steam turbine (not shown). Combustion gases are collected in the freeboard 22, are cleaned in the cleaning plant 14, symbolized by a cyclone, and are supplied to the turbine 24. The turbine 24 drives the compressor 26 which feeds the space 28 in the pressure vessel 10 with compressed combustion air. On its way to nozzles 30 at the bottom 32 of the combustor 12, the combustion air passes through the pressure-reducing ash discharge device 16 which is designed as a cooler. This device 16 is placed in a channel 34 for the combustion air.

From the cyclone 14, separated dust is transported pneumatically with combustion gases as transport gas through the ash discharge device 16 formed as a cooler, where the dust and the gas are cooled from about 850°C to 300-400°C, and the conduit 35 to the subsequently located cooler 36, where the dust is cooled to < 100°C. This second cooler 36 is formed as a vertical container with a space 40 in the upper part for separation of dust from the transport gas and with a vertical duct 42 in its lower part, where separated dust forms a material column 44 with an upper surface 46. In the embodiment shown, the duct 42 includes three cooling modules 48a, 48b, 48c, connected in series. Cooling water is supplied to the lowemost module and is discharged from the uppermost one. Thus, in the duct 42 material and cooling water will flow in opposite directions. Alternatively, it is possible to supply the cooling modules 48a, 48b, 48c with cooling water from different sources with different water temperatures. The lowermost cooling module 48a is supplied

CLAIMS

1. A cooler for particulate material from a combustion plant, which material is supplied to the cooler via an inlet together with flue gases, **characterized in that**

a separation space (40) is provided at the inlet for separation of flue gases and the particulate material,

from said separation space (40) there is an outlet for the flue gases with a gas cleaner (56),

below said separation space (40) there is a downwardly directed, preferably vertical duct (42) which receives the particulate material,

said duct (42) includes cooling devices (48a-c) for cooling of the particulate material,

the lower part of said duct (42) is provided with devices (82a-c) for the supply of gas, for example air, for discharging flue gases from a column (44) of the particulate material in order to reduce the dew point of gas in the cooler and to stir the particulate material, and in that

the lower part of the duct (42) is provided with a device (60) for discharging cooled material from the cooler.

2. A cooler according to claim 1, **characterized in that** it is included in a PFBC power plant and receives dust from a cleaning plant (14) for flue gases, said dust being transported pneumatically to the cooler by flue gases as transport means.

3. A cooler according to claim 2, **characterized in that** the particulate material and the transport gas are supplied to the separation space (40) of the cooler via a pressure-

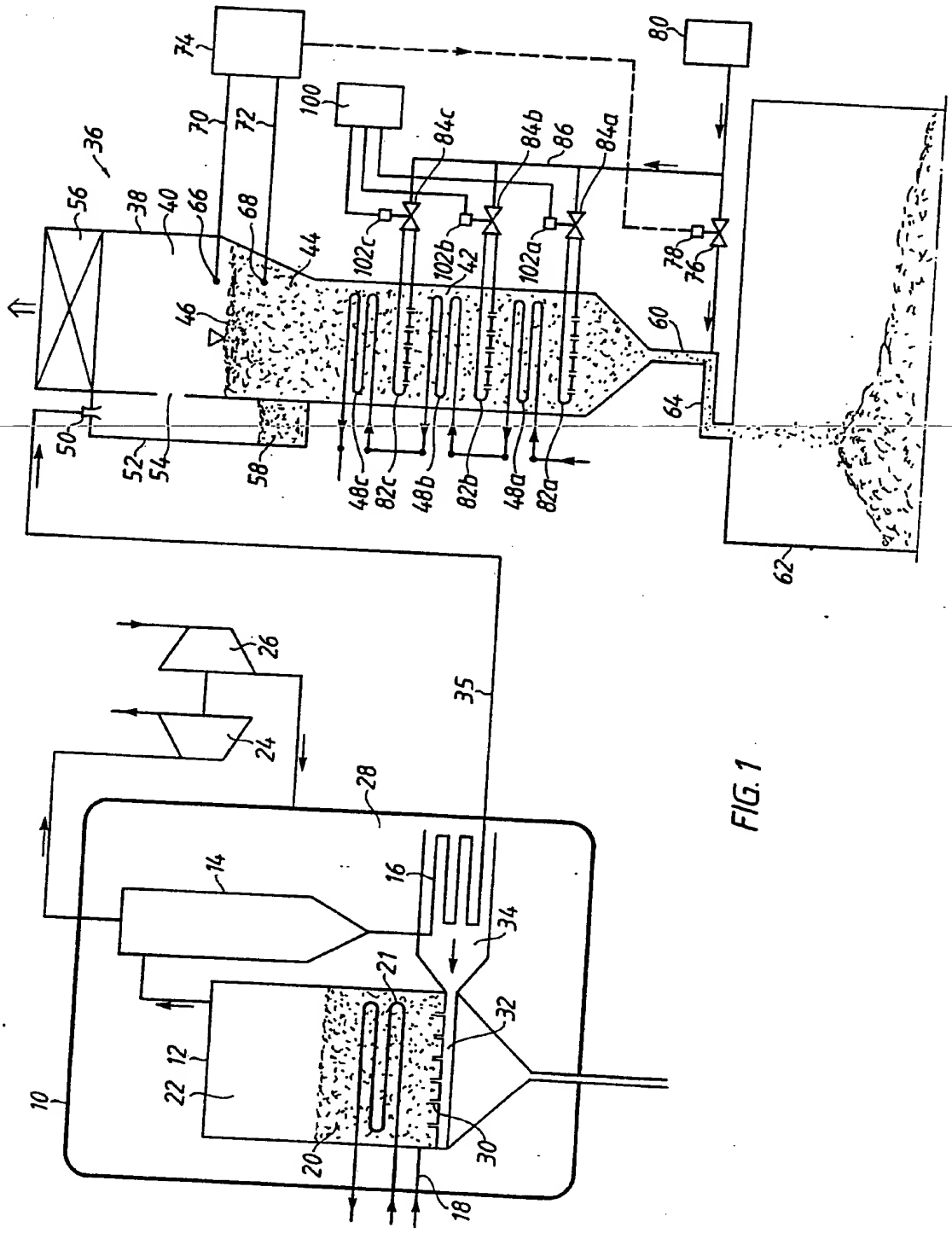

74
80
100
70
72
84c
84b
86
84a
36
56
38
40
66
68
44
102c
102b
42
102a
78
76
46
60
64
50
52
54
58
48c
82c
48b
82b
48a
82a
62
26
35
24
28
14
16
34
21
32
12
22
10
20
30
18

FIG. 1

# INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 91/00305

## I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: F 23 J 3/00, F 28D 7/00, F 28 D 13/00, F 27 B 15/12 // F 23 C 11/02

## II. FIELDS SEARCHED

| Minimum Documentation Searched[7] | |
|---|---|
| Classification System | Classification Symbols |
| IPC5 | F 22 B; F 23 C; F 23 J; F 27 B; F 28 D |

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in Fields Searched[8]

SE,DK,FI,NO classes as above

## III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

| Category * | Citation of Document,[11] with indication, where appropriate, of the relevant passages[12] | Relevant to Claim No.[13] |
|---|---|---|
| X | US, A, 4544020 (CHRYSOSTOME ET AL) 1 October 1985, see column 6, line 43 - line 65; column 6, line 13 - line 22; figures 5,4 | 1,7,8, 10,11 |
| Y | -- | 2-6,9, 12 |
| Y | WO, A1, 9000702 (ABB STAL AB) 25 January 1990, see figure 1 | 2,3, 12 |
| Y | -- | |
| Y | DE, C2, 2414768 (JANICH, H-J.) 27 June 1985, see figure 1 | 4,5 |
| Y | -- | |
| Y | US, A, 3705620 (KAYATZ) 12 December 1972, see figure 3 | 4,6 |
| | -- | |

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step.

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

## IV. CERTIFICATION

| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report |
|---|---|
| 25th July 1991 | 1991 -07- 30 |
| **International Searching Authority** | **Signature of Authorized Officer** |
| SWEDISH PATENT OFFICE | Anders Bruun |

Form PCT/ISA/210 (second sheet) (January 1985)

# ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 91/00305

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 91-06-27
The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

| Patent document cited in search report | Publication date | Patent family member(s) | | Publication date |
|---|---|---|---|---|
| US-A- 4544020 | 85-10-01 | CA-A- | 1218983 | 87-03-10 |
| | | EP-A-B- | 0095427 | 83-11-30 |
| | | FR-A-B- | 2527760 | 83-12-02 |
| | | JP-A- | 59001990 | 84-01-07 |
| WO-A1- 9000702 | 90-01-25 | EP-A- | 0423187 | 91-04-24 |
| | | SE-B-C- | 461679 | 90-03-12 |
| | | SE-A- | 8802526 | 90-01-07 |
| DE-C2- 2414768 | 85-06-27 | NONE | | |
| US-A- 3705620 | 72-12-12 | AT-A- | 298320 | 72-03-15 |
| | | BE-A- | 763861 | 71-08-02 |
| | | DE-A- | 2010601 | 71-11-18 |
| | | FR-A- | 2084254 | 71-12-17 |
| | | GB-A- | 1290639 | 72-09-27 |
| US-A- 3242974 | 66-03-29 | NONE | | |
| DE-C2- 3112120 | 86-08-07 | EP-A-B- | 0062092 | 82-10-13 |
| | | JP-B- | 1017044 | 89-03-28 |
| | | JP-C- | 1535351 | 89-12-21 |
| | | JP-A- | 57166412 | 82-10-13 |
| US-A- 4227488 | 80-10-14 | CA-A- | 1132852 | 82-10-05 |
| | | GB-A-B- | 2032598 | 80-05-08 |
| | | JP-A- | 55049137 | 80-04-09 |
| | | NL-A- | 7907309 | 80-04-09 |
| | | SE-A- | 7907643 | 80-04-04 |